AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.4.1

Nuclear fission

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**16**
Available paper years	**2004–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.4.4.1 Nuclear fission

Answer 01 · Mark scheme June 2004 | 3451H | Original Q10 | Legacy

The full source mark scheme begins on page 30. Follow original question 10 in that document.

Answer 02 · Mark scheme June 2004 | 3462H3 | Original Q8 | Legacy

The full source mark scheme begins on page 51. Follow original question 8 in that document.

4.4.4.1 Nuclear fission

Answer 03 · Mark scheme January 2008 | PHY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
(a)(i)	(nuclear) fission	accept fision providing clearly **not** fusion	1
(ii)	(released) neutrons are absorbed by further (uranium) nuclei more neutrons are released (when new nuclei split)	accept hit nuclei for absorbed / hit do **not** accept atom for nuclei accept for **both** marks a correctly drawn diagram	1 1
(iii)	increases by 1 **or** goes up to 236		1
(b)	any **two** from: • (more) neutrons are absorbed • (chain) reaction slows down / stops • less energy released	 accept there are fewer neutrons accept keeping the (chain) reaction controlled accept heat for energy accept gases (from reactor) are not as hot	2
total			6

4.4.4.1 Nuclear fission

Answer 03 · Mark scheme

January 2008 | PHY2H | Original Q4 | Legacy

PHY2H

4.4.4.1 Nuclear fission

Answer 04 · Mark scheme

Question 6

question	answers	extra information	mark
(a)(i)	3 fewer neutrons	accept fewer neutrons accept different number of neutrons do **not** accept different number of electrons	1
(a)(ii)	electron from the nucleus	both points needed	1
(a)(iii)	32 (days)	allow **1** mark for clearly obtaining 4 half-lives	2
(a)(iv)	has a **<u>much</u>** longer half-life little decay happened / still in the atmosphere	accept converse answers in terms of iodine-131 accept it has not reached one half-life yet accept it is still decaying	1 1
(b)	any **two** from: • some children developed TC before 1986 • some children (after 1986) that developed TC did not live in highly contaminated areas • the (large) increase can (only) be explained by (a large increase in) radiation as caused by Chernobyl • all areas would be contaminated (and raise the risk of TC) • no evidence (of effect) of other variables	marks are for reasons	2
(c)	People not exposed (to the radiation but who were otherwise similar)	accept people not affected (by the radiation)	1

Question 6 continues on the next page

4.4.4.1 Nuclear fission

PHY1H

Question 6 continued

question	answers	extra information	mark
(d)	any **two** from: • produce no pollutant / harmful gases • produces a lot of energy for a small mass (of fuel) **or** is a concentrated energy source • it is reliable **or** it can generate all of the time • produces only a small volume of (solid) waste	answers should be in terms of nuclear power and **not** why we should not use other fuels accept named gas or greenhouse gases do **not** accept no pollution accept amount for mass accept high energy density accept amount for volume	2
total			11

4.4.4.1 Nuclear fission

Answer 05 · Mark scheme January 2009 | PHY1H | Original Q3 | Legacy

Question 3

question	answers	extra information	Mark
3(a)	1/25 **or** 1:25 **or** 0.04	accept 4 % **or** $\frac{15}{375}$ **or** $\frac{3}{75}$ **or** 1 in *25* for both marks allow **1** mark for total of 375 allow **1** mark for a clearly correct method using a clearly incorrect total do **not** accept 1:26	2
3(b)(i)	**B** (only) burning fossil fuels produces carbon dioxide / carbon (emissions) **or** nuclear fuels don't produce carbon dioxide	do **not** credit reason if **B** is not chosen insufficient – smallest amount of fossil fuels accept less carbon dioxide	1 1
3(b)(ii)	accept anything reasonable eg increased level of insulation use energy efficient light bulbs do not leave appliances on standby switch thermostats down (1 ^{o}C) generate own electricity install solar panels	accept insulate accept specific examples eg loft	1

Question 3 continues on the next page

PHY1H

Question 3 continued

question	answers	extra information	Mark
3(c)(i)	any **three** from: • no power output until wind speed exceeds 4 m/s • output rises rapidly after 4 m/s • output begins to level out / rises less rapidly at / after 13 m/s • output peaks at 21 / 22 m/s • output constant between 21 / 22 and 25 / 26 m/s • output falls (rapidly) after 25 / 26 m/s	accept for **1** mark goes up then comes down	3
3(c)(ii)	any **one** from: • unreliable energy source • dilute energy source • take up too much land	accept wind does not always blow accept need thousands / lots of turbines ignore reference to visual / noise pollution ignore reference to kill birds	1
Total			**9**

4.4.4.1 Nuclear fission

Answer 05 · Mark scheme January 2009 | PHY1H | Original Q3 | Legacy

PHY1H

Answer 06 · Mark scheme June 2009 | PHY1AP | Original Q5 | Legacy

Five	**2**	**3**	**2**	**4**

4.4.4.1 Nuclear fission

Answer 07 · Mark scheme June 2009 | PHY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)	Particle: Proton — Relative Mass: 1 — Relative charge: Particle: Neutron — Relative Mass: — Relative charge: 0	accept one, accept +1 do **not** accept -1 accept zero do **not** accept no charge/ nothing/ neutral unless given with 0	1 1
1(b)	equal numbers/amounts of protons and electrons protons and electrons have equal but opposite charge	 accept protons charge +1 and electron charge -1 accept (charge on) proton cancels/balances (charge on) electron accept positive (charges) cancel out the negative(charges) neutrons have no charge is neutral do **not** accept total charge of protons, electrons (and neutrons) is 0 unless qualified	1 1

Question 1 continues on the next page . . .

4.4.4.1 Nuclear fission

PHY2H

Question 1 continued . . .

question	answers	extra information	mark
1(c)(i)	(3) fewer neutrons . . .	accept lower/ smaller mass number do **not** accept different numbers of neutrons any mention of fewer/more protons or electrons negates mark accept answers in terms of U-238 providing U-238 is specifically stated i.e. U-238 has (3) more neutrons	1
1(c)(ii)	neutron		1
1(c)(iii)	(nuclear) fission	accept fision do **not** accept any spelling that may be taken as fusion	1
Total			**7**

4.4.4.1 Nuclear fission

Answer 07 · Mark scheme June 2009 | PHY2H | Original Q1 | Legacy

PHY2H

4.4.4.1 Nuclear fission

Answer 08 · Mark scheme

June 2010 | PHY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	isotopes		1
4(b)	$^{231}_{90}$Th	correct order only	1 1
4(c)(i)	(nuclear) fission	accept fision do **not** accept any spelling that may be confused with fusion	1
4(c)(ii)	neutron / neutrons		1
4(d)	plutonium (239)	accept MOX (mixed oxide) accept Pu do **not** accept uranium 238 / hydrogen	1
Total			**6**

4.4.4.1 Nuclear fission

Answer 08 · Mark scheme June 2010 | PHY2H | Original Q4 | Legacy

PHY2H

4.4.4.1 Nuclear fission

Answer 09 · Mark scheme

June 2013 | PH2HP | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)(i)	plutonium (239)	accept Pu / Thorium / MOX (mixed oxide) do **not** accept uranium-238 **or** hydrogen	1
3(a)(ii)	(energy) used to heat water and produce (high pressure) steam the steam drives a turbine (which turns a generator)		1 1 1
3(b)	Neutron(s) shown 'hitting' other U-235 nuclei U-235 nuclei (splitting) producing 2 or more neutrons	one uranium nucleus is sufficient	1 1
3(c)	any **two** from: • neutrons are absorbed (by boron / control rods) • there are fewer neutrons • chain reaction slows down / stops	accept fewer reactions occur	2
Total			**8**

4.4.4.1 Nuclear fission

Answer 09 · Mark scheme

June 2013 | PH2HP | Original Q3 | Legacy

PH2HP

4.4.4.1 Nuclear fission

Answer 10 · Mark scheme June 2014 | PH2HP | Original Q6 | Legacy

6(a)	(same) number of protons	same atomic number is insufficient	1	AO1 2.5.1e
6(b)(i)	nuclei split	do **not** accept atom for nuclei / nucleus	1	AO1 2.6.1b
6(b)(ii)	(nuclear) reactor		1	AO1 2.6.1a
6(c)	beta any **one** from: • atomic / proton number increases (by 1) • number of neutrons decreases / changes by 1 • mass number does not change • a neutron becomes a proton	 accept atomic / proton number changes by 1 (total) number of protons and neutrons does not change	1 1	AO2 2.5.2d
6(d)	(average) time taken for number of nuclei to halve **or** (average) time taken for count-rate / activity to halve		1	AO1 2.5.2h

Question 6 continues on the next page . . .

4.4.4.1 Nuclear fission

Question 6 continued . . .

Question	Answers	Extra information	Mark	AO spec ref
6(e)(i)	6.2 (days)	Accept 6.2 to 6.3 inclusive allow **1** mark for correctly calculating number remaining as 20 000 **or** allow **1** mark for number of 80 000 plus correct use of the graph (gives an answer of 0.8 days)	2	AO2 2.5.2h
6(e)(ii)	radiation causes ionisation that may then harm / kill healthy cells	allow radiation can be ionising accept specific examples of harm, eg alter DNA / cause cancer	1 1	AO3 2.5.2g
6(e)(iii)	benefit (of diagnosis / treatment) greater than risk (of radiation)	accept may be the only procedure available	1	AO3 2.5.2g
Total			**11**	

4.4.4.1 Nuclear fission

Answer 10 · Mark scheme

June 2014 | PH2HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO spec ref

4.4.4.1 Nuclear fission

Answer 11 · Mark scheme June 2015 | PH2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
3(a)(i)	splitting of a(n atomic) nucleus	do not accept splitting an atom	1	AO1 2.6.1b	**E**
3(a)(ii)	Neutron		1	AO1 2.6.1c	**E**
3(b)(i)	nuclei have the same charge **or** nuclei are positive	accept protons have the same charge	1	AO1 2.3.1d	**E**
3(b)(ii)	(main sequence) star	accept Sun or any correctly named star accept red (super) giant	1	AO1 2.6.2b	**E**
3(c)(i)	any **two** from: • easy to obtain / extract • available in (very) large amounts • releases more energy (per kg) • produces little/no radioactive waste	do **not** accept figures *only* naturally occurring is insufficient seawater is renewable is insufficient less cost is insufficient	2	AO2/3 2.6	**E**
3(c)(ii)	any **one** from: • makes another source of energy available • increases supply of electricity • able to meet global demand • less environmental damage • reduces amount of other fuels used	accept any sensible suggestion accept a specific example accept a specific example	1	AO3 2.6	**E**
3(d)	12	allow **1** mark for obtaining 3 half-lives	2	AO2 2.5.2h	**E**

4.4.4.1 Nuclear fission

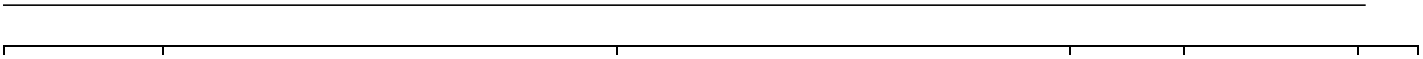
Answer 11 · Mark scheme

Total			**9**

4.4.4.1 Nuclear fission

Answer 11 · Mark scheme

June 2015 | PH2HP | Original Q3 | Legacy



4.4.4.1 Nuclear fission

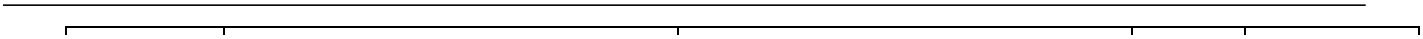
Answer 12 · Mark scheme June 2017 | PH2HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)	uranium (-235)	ignore an incorrect number given with uranium U- 235 is insufficient	1	AO1 2.6.1a
1(b)(i)	neutron		1	AO1 2.6.1c
1(b)(ii)	(nucleus) splits (into two parts) and (two / three) neutrons	do not accept atom splits accept a correctly labelled diagram for full or partial credit ignore reference to energy released	1 1	AO1 2.6.1d
Total			**4**	

4.4.4.1 Nuclear fission

Answer 12 · Mark scheme

June 2017 | PH2HP | Original Q1 | Legacy



4.4.4.1 Nuclear fission

Answer 13 · Mark scheme June 2018 | 8463/1H | Original Q8

Question	Answers	Extra information	Mark	AO/ Spec. Ref
08.1	any **three** from: • no carbon dioxide emitted (to produce electricity) • doesn't cause global warming • nuclear power doesn't cause earthquakes • more energy released per kg of fuel (compared to shale gas)	no greenhouse gases is insufficient allow climate change or greenhouse effect for global warming	3	AO1 AO2 4.1.3
08.2	uranium **or** plutonium	ignore any numbers given	1	AO1 4.4.4.1
08.3	a neutron is absorbed by a (large) nucleus the nucleus splits into two (smaller) nuclei releasing energy (and gamma rays) and (two / three) neutrons	a description in terms of only atoms negates first two marking points	1 1 1 1	AO1 4.4.4.1
Total			**8**	

4.4.4.1 Nuclear fission

Answer 14 · Mark scheme

November 2020 | 8463/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	Any **one** from: • (medical) x-rays • radiotherapy • nuclear weapons (testing) • named nuclear disaster eg Chernobyl / Fukushima / Three Mile Island.	allow CT scans allow nuclear fallout ignore radioactive / nuclear waste	1	AO1 4.4.3.1
05.2	uranium / plutonium	ignore any number given allow thorium	1	AO1 4.4.4.1
05.3	neutron absorbed by a uranium nucleus nucleus splits into two parts and (2 / 3) neutrons (are released) and gamma rays (are emitted)	allow an atom splits into two parts if 1st marking point doesn't score	1 1 1 1	AO1 4.4.4.1
05.4	lighter nuclei join to form heavier nuclei some of the mass (of the nuclei) is converted to energy (of radiation)	allow specific examples	1 1	AO1 4.4.4.2
05.5	activity decreases quickly risk of harm decreases quickly	allow nuclei / waste will decay at a greater rate ignore waste is radioactive for less time allow burial site doesn't need to be monitored for as long **or** doesn't need to be buried underground for as long **or** may not need to be buried underground	1 1	AO3 4.4.2.3
Total			**10**	

4.4.4.1 Nuclear fission

Answer 15 · Mark scheme

June 2024 | 8463/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	nuclei neutrons gamma (rays)	this order only	1 1 1	AO1 4.4.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	energy = power × time **or** $E = P \times t$		1	AO1 4.2.4.2 4.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	P = 500 000 000 (W)		1	AO2 4.2.4.2 4.1.1.4
	E = 500 000 000 × 3600	allow a correct substitution of an incorrectly / not converted value of P	1	
	E = 1 800 000 000 000 (J) **or** $E = 1.8 \times 10^{12}$ (J)	allow an answer consistent with an incorrectly / not converted value of P	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	any **one** from: • bury the radioactive waste • put the radioactive waste in cooling ponds • transport the radioactive waste in secure vessels • store the radioactive waste in metal containers • cover the radioactive waste in concrete	allow store it for (at least) one half-life ignore references to high / medium / low level waste ignore label the waste as hazardous	1	AO3 4.4.2.4

4.4.4.1 Nuclear fission

Answer 15 · Mark scheme

June 2024 | 8463/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	number of days = $\frac{92}{100} \times 365$		1	AO2 4.1.3
	number of days = 335.8	allow answers of 335 and 336 days allow an answer of 29.2 (days) for 1 mark	1	

Total Question 2	10

4.4.4.1 Nuclear fission

Answer 16 · Mark scheme

June 2025 | 8463/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(atoms of an element with) the same number of protons but a different number of neutrons	ignore number of electrons allow same atomic number allow different mass number	1 1	AO1 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	light(er) nuclei fuse to form heavier nuclei / elements some of the mass (of the nuclei) is converted into energy (of radiation)	allow hydrogen nuclei fuse ignore bonding / colliding allow to form helium nuclei	1 1 1	AO1 4.4.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(a large amount of energy transferred) causes a small temperature increase of the walls / material (therefore) the walls of the reactor should not reach melting point	 allow (therefore) the walls of the reactor should not melt	1 1	AO3 4.1.1.3 4.3.2.2 4.3.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	any **one** from: • a nuclear explosion • a (nuclear) meltdown • a nuclear bomb	allow atomic for nuclear allow Chernobyl / Fukushima (disaster)	1	AO1 4.4.4.1

Total Question 5	8

GCSE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics Specification B
3451/F

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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4.4.4.1 Nuclear fission

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4.4.4.1 Nuclear fission

GCSE PHYSICS

INFORMATION FOR EXAMINERS

1. General

The mark scheme for each question shows:

- the marks available for each part of the question;
- the total marks available for the question;
- the typical answer or answers which are expected;
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example:
where consequential marking needs to be considered in a calculation;
or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.)

3. Marking points

3.1 Marking of Quality of Written Communication

Where *Quality of written communication* appears in the mark scheme, one mark is to be awarded for either of the following points:

- Using correct scientific terms
- Correct sequencing or linking of ideas or points

The mark scheme will specify which of the points is to be awarded in a particular question. A QoWC mark can be awarded for a scientific answer, even if it is not accurate. It cannot be awarded for a nonsensical or non-scientific answer.
On the script, the QoWC tick should be identified by a 'q' written next to it.

3.2 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

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Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.3 Use of chemical symbols/formulae

If a candidate writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.4 The marking of quantitative relationships

Full credit can be given for a correct quantitative relationship expressed in:

- named units;
- physical quantities;
- standard symbols;
- a combination of physical quantities and units.

No credit can be given for any quantitative relationship expressed in terms of:

- a combination of physical quantities, units and symbols;
- a diagram, e.g. the ohm's law triangle, unless the rest of the answer shows clearly that the candidate understands the relationships involved.

3.5 Marking procedure for calculations

3.5.1 Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.
However:

- if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column;
- if the answer is correct, but an incorrect relationship is written in the working, then no marks can be awarded (see 3.5.2).

3.5.2 Where calculations are based on incorrectly recalled relationships, neither the incorrectly recalled relationship, nor the resulting calculation based on the incorrect relationship, will be credited.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

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4.4.4.1 Nuclear fission

3.7 Errors carried forward

There should be no error carried forward from a previous answer which has been based on wrong science. Any error in the answers to a structured question should be penalised once only.

Examples

(a) A candidate who calculates average speed using speed = time/distance **and** then proceeds to use this incorrect answer to calculate an acceleration based on the correct quantitative relationship should be given credit for the use of the correct acceleration relationship but none for either numerical answer.

(b) A candidate who incorrectly calculates average speed using speed = distance/time and then proceeds to use this incorrect value to calculate an acceleration based on the correct quantitative relationship, should be given credit for the use of both correct quantitative relationships **and** for the correct substitution and use of the incorrect value in the calculation of the rate of acceleration.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.8 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.9 Brackets

(…..) is used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.10 Interpretation of marginal points

There will be times when the answer is almost, but not quite, correct. Some examiners would award a mark while others would not. In any one script, an attempt should be made to balance these nearly correct answers by giving the mark on some occasions but not on others. If this is not done, the marking would end up being too lenient or too harsh.

3.11 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

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4.4.4.1 Nuclear fission

GCSE Physics
Foundation Tier 3451/F

3451F Q1

question	answers	extra information	mark
(a)	comet	correct order only	1
	elliptical		1
	Milky Way		1
	Universe		1
(b)(i)	D A C B	allow **2** marks for two letters in the correct place allow **1** mark for one letter in the correct place	3
(ii)	A		1
total			8

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4.4.4.1 Nuclear fission

3451F Q2

question	answers	extra information	mark
(a)	95		1
(b)	alpha	accept correct symbol	1
(c)	any **two** from: • radiation is outside the body • radiation will not reach (living) cells • radiation absorbed by the air	 accept detector is on ceiling or high up the wall accept radiation cannot pass through the body / skin accept cannot pass through the plastic casing do **not** accept because it is alpha radiation – unless qualified do **not** accept does not give off harmful substance do **not** accept cannot pass through building materials etc.	2
(d)	less (than)		1
total			5

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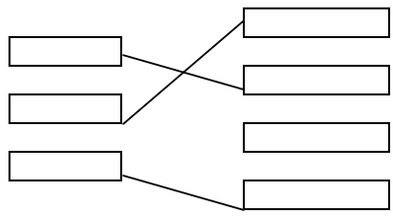
4.4.4.1 Nuclear fission

3451F Q3

question	answers	extra information	mark
(a)	generator	accept dynamo accept alternator	1
(b)(i)	1400	ignore units	1
(ii)	0.3 or 30%	any incorrect unit penalise **1** mark allow **1** mark for the correct use of 600 **or** 0.3% **or** 30	2
(c)	**1** mark for each correct link 	if more than 3 lines are drawn, mark only 3 lines starting with those that are incorrect	3
(d)(i)	110	no tolerance	1
(ii)	12	no tolerance	1
(iii)	wind speed may be too low to operate the generator	accept wind may not always blow accept power depends on wind speed accept does not generate if wind speed is too high accept does not generate if wind speed is above 12 (m/s) accept does not generate if wind speed is below 1.6 (m/s) accept it is unreliable do **not** accept answers referring to cost only	1
total			10

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4.4.4.1 Nuclear fission

3451F Q4

question	answers	extra information	mark
(a)	B E A D	allow **1** mark for each letter in the correct place, to a maximum of **3** marks	3
(b)	(a spark) may cause the (petrol vapour) to explode / ignite	accept petrol for (petrol vapour) accept catch fire for explode	1
	connect tanker to earth with a (conducting) wire / chain **or** earth the tanker	accept ground for earth	1
(c)	**Quality of written communication**	for a logical sequence	1
	any **two** from:		2
	• when current greater than fuse rating / value	accept when current too great for appliance do **not** accept 'if there is too much current' do **not** accept voltage or electricity	
	• fuse (becomes hot and) melts / burns out	accept fuse blows / breaks	
	• circuit is broken	accept circuit switched off this cannot score credit on its own	
total			8

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4.4.4.1 Nuclear fission

3451F Q5

question	answers	extra information	mark
(a)(i)	crust		1
(ii)	inner core is <u>solid</u> outer core is liquid	do **not** accept just rock inner core is denser / hotter than outer core gets **2** marks accept one is solid and one is liquid for **1** mark accept they are different densities for **1** mark wrong way round = **0** marks	1 1
(b)	seismograph		1
(c)	difficult to measure (slow) movement (1) of plates (1) dependent mark **or** difficult to measure friction / forces (1) between plates (1) dependent mark		1 1
(d)	geothermal		1
(e)(i)	5000		1
(ii)	2500		1
total			9

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4.4.4.1 Nuclear fission

3451F Q6

	answers	extra information	mark
(a)	converging image object image object shorter		1 1 1 1 1 1
(b)(i)	(Earth's) gravity	accept centripetal accept minor misspellings, however, do **not** credit any response which could be 'centrifugal'	1
(ii)	to(wards) (the centre of the) Earth	allow inwards do **not** accept downwards	1
(c)(i)	**either** friction (force) **or** centripetal force between the tyres / wheels and (the surface of) the road	 allow grip allow on the tyres / wheels **or** towards the centre of the bend / arc / circle	 1 1
(ii)	mass **or** speed **or** momentum radius / diameter	allow weight allow velocity do **not** credit 'curvature' or 'circumference'	1 1
(d)	centripetal	accept minor misspellings (see above)	1
total			13

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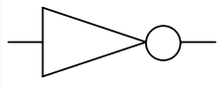
4.4.4.1 Nuclear fission

3451F Q7

	answers	extra information	mark
(a)(i)	two switches in series **and** circuit complete	ignore small imperfections	1
(ii)	two switches in parallel **and** circuit complete	ignore small imperfections	1
(iii)	one switch in parallel with the cell / lamp (but **not** both)	ignore small imperfections	1
(iv)	(i) AND (ii) OR (iii) NOT	accept 'and' accept 'or' accept 'not'	1 1 1
(b)(i)	when it is light the sensor sends on / high / 1 signal to the gate off / low / 0 sent to the lamp **or** when it is dark the sensor sends off / low / 0 signal to the gate (1) on / high / 1 sent to the lamp (1)		1 1
(ii)	any suitable application	e.g. to switch a security light on (and off) e.g. to switch a light on when it is dark do **not** credit just '… to switch a light on / off'	1
(c)(i)		accept shading-in of either or both parts end connections are not required accept any orientation	1
(ii)	1 0 **or** 0 1 0 1 1 0	all correct	1
(iii)	truth (table)		1
total			12

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4.4.4.1 Nuclear fission

3451F Q8

question	answers	extra information	mark
(a)	60		1
(b)	$5\frac{1}{2}$ hours	must include unit	1
(c)	30		1
(d)	30 minutes or $\frac{1}{2}$ hour	must include unit	1
(e)	D **and** E least steep part of the graph	accept finish for E accept correct numbers from axes with units accept covers smallest distance in a set time accept only moves 5 km in $1\frac{1}{2}$ hours (accept anything between 5 and 6) ignore horse is tired	1 1
total			6

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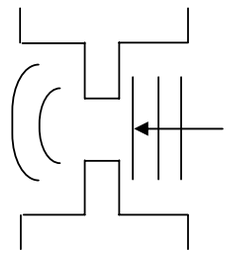
4.4.4.1 Nuclear fission

3451F Q9

question	answers	extra information	mark
(a)(i)	any **one** from: • (doctors) to see inside a patients body **or** endoscope • telephone cables • optical fibre / fibre optic lamps **or** (artificial) Christmas trees • data transfer **or** internet connection	 accept keyhole surgery do **not** accept flex **or** wires for cable accept decorative / ornamental lighting accept any feasible practical suggestion for taking light to a difficult to access place do **not** accept lighting unqualified do **not** accept lamp unqualified do **not** accept communications unless clarified	1
(ii)	(incident) ray angle greater than critical angle total internal reflection occurs	either order accept (incident) ray greater than 42° accept TIR do **not** accept just description of TIR	1 1
(b)(i)	waves shown diffracting in the correct direction 	ignore wavelength	1
(ii)	diffraction	accept diffract / diffracted	1
total			5

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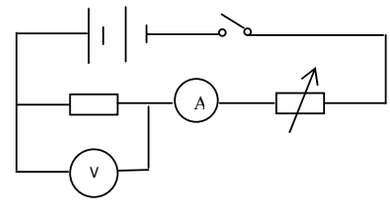
4.4.4.1 Nuclear fission

3451F Q10

question	answers	extra information	mark
(a)	all symbols correct	 accept push switch symbol switch may be open or closed any lines through symbols = **0** marks	1
	correct circuit drawn voltmeter must be across resistor only	polarity of cells not relevant provided they are joined correctly two cells are required in the diagram ignore the order of the components allow small gaps in circuit omission of any component = **0** marks	1
(b)(i)	potential difference = current × resistance	accept voltage or p.d. for potential difference accept $V = I \times R$ accept  provided subsequent use correct do **not** accept C for current	1
(ii)	2	 allow **1** mark for correct substitution wrong working loses both marks	2
(iii)	straight line drawn <u>through the origin</u> straight line passes through $I = 0.4, V =$ their (b)(ii) / 2 **and** 0.0	judge by eye this mark may be awarded if all points shown including these points are correct even if no line is drawn N.B. a curve scores **0** marks	1 1 dep
(c)	temperature <u>increases</u>	accept filament lamp / it gets <u>hotter</u> allow heat for temperature	1
total			8

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4.4.4.1 Nuclear fission

3451F Q11

question	answers	extra information	mark
(a)(i)	gamma rays	accept gamma accept correct symbol	1
(ii)	infra red	accept IR	1
(b)	ultraviolet <u>absorbed</u> by ink (energy) given out as light	 accept glows / luminous accept for **both** marks the ink is fluorescent do **not** accept answers in terms of uv being reflected	1 1
(c)	any **two** from: • UV can damage / kill / ionise / alter (normal) cells • change DNA structure **or** mutate • (normal) cells may become cancerous	 do **not** accept attacks cells **or** burns skin accept may cause (skin) cancer accept abnormal cell multiplication	2
(d)(i)	microwaves **and** infra red	both answers needed in either order do **not** accept heat for IR	1
(ii)	0.9	 allow **1** mark for the <u>correct</u> use of 1.8 (kW) $(1.8 \times \frac{1}{2}$ or $1.8 \times 30)$ i.e. adding the correct 2 power values	2
total			9

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4.4.4.1 Nuclear fission

3451F Q12

question	answers	extra information	mark
(a)(i)	accelerating	accept getting faster accept speed / velocity increasing	1
(ii)	acceleration <u>increases</u>	accept velocity / speed increases <u>more</u> rapidly do **not** accept velocity / speed increases	1
(b)(i)	$\text{acceleration} = \frac{\text{change in velocity}}{\text{time (taken)}}$	accept $a = \frac{v - u}{t}$ **or** $a = \frac{v_1 - v_2}{t}$ do **not** accept velocity for change in velocity do **not** accept change in speed do **not** accept $a = \frac{v}{t}$	1
(ii)	15	allow **1** mark for an answer of 900 **or** for <u>correct</u> use of 540 seconds	2
(iii)	velocity includes direction	accept velocity is a vector (quantity) accept converse answer	1
(c)	force of gravity (between <u>shuttle</u> and Earth) plus correct orbital speed (makes <u>shuttle</u> move in a curve)	accept gravitational pull if used correctly accept forward motion **or** constant speed for orbital speed accept it is travelling fast enough accept for **2** marks the force of gravity provides the <u>centripetal</u> force	1 1
(d)	black is a good emitter of radiation **or** to limit the temperature rise inside the shuttle	accept heat for radiation accept the tiles are good insulation do **not** accept black absorbs heat on its own do **not** accept tiles are heat proof	1
total			9

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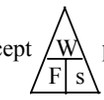
4.4.4.1 Nuclear fission

3451F Q13

question	answers	extra information	mark
(a)(i)	work (done) = force (applied) × distance (moved)	accept $W = F \times s$ or $W = F \times d$ accept  provided subsequent method is correct	1
(ii)	240 000 joules	allow **1** mark for correct substitution **or** correct use of 1200 (N) accept J do **not** accept j / Nm	2 1
(b)	800 (watts)	accept 0.8 kW accept their (a)(ii) ÷ 300 correctly evaluated for **2** marks allow **1** mark for correct substitution (a)(ii) ÷ 5 correctly evaluated for **1** mark	2
(c)(i)	any **one** from: • needs to raise the chair / lift • lifting more than one chair • energy transfer to the surroundings correctly qualified	 allow lifting more than 2 people implication of a heavier weight accept loss for transfer do **not** accept motor inefficient do **not** accept motor gets hot do **not** accept friction unless the location is specified as external to the motor	1
(ii)	electrical potential	accept electric **both** answers required for the mark	1
total			8

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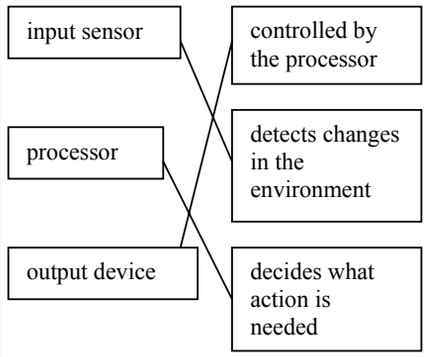
4.4.4.1 Nuclear fission

3451F Q14

	answers	extra information	mark
(a)(i)	current		1
(ii)	resistance decreases	 accept 'the flow of electrons / current (through it) increases' for **1** mark do **not** credit just '… it will get warmer'	1 1
(b)		all pairs correct one pair correct for **1** mark	2
(c)(i)	potential divider	accept voltage divider	1
(ii)	4 (volts)	$6 \times \frac{30}{45}$ for **1** mark	2
(iii)	across the new resistor…(will) increase across R_2 … (will) decrease	 N.B. independent marks	1 1
total			10

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4.4.4.1 Nuclear fission

3451F Q15

	answers	extra information	mark
(a)	relay (normally open) (switch)	each mark is independent	1
	… switch on a (larger) current (in another circuit) **or** switch on a higher voltage circuit	do **not** accept switch on another circuit **or** smaller / equal current	1
	light emitting diode / LED	do **not** credit LDR	1
	… in one / direct / certain direction **or** from left to right	**or** when the cathode is connected to the negative terminal / side **or** when the left-hand side is connected to the positive terminal / side do **not** credit just '… is big enough' do **not** accept 'positive direction'	1
	AND gate	accept 'and' gate	1
	… (both) inputs are on / high / 1 **or** current flows in both inputs	do **not** accept numerical values unless expanded	1
(b)	**Quality of written communication**	If in a sensible order which clearly indicates advantages or disadvantages, including answers in the form of a table **or** as bullet points Q ✓ Q X	1
	any **three** from: • advantage of mobile phones • drawback of mobile phones • benefit of the Internet • drawback of the Internet	 e.g. more convenient for service engineers e.g. calls can be received away from base e.g. privacy can be more easily invaded e.g. drivers can be distracted e.g. microwaves / radio waves can / may cause damage to the brain e.g. access to educational material e.g. some material is salacious e.g. spam (on external e-mail) these are examples candidates may be credited for a variety of responses	3
total			10

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4.4.4.1 Nuclear fission

3451F Q16

question	answers	extra information	mark
(a)	**Y** and **Z**		1
	they have the same number of protons **or** same atomic number	accept they have the same number of electrons **or** same number of protons **and** electrons allow only different in number of neutrons N.B. independent marks	1
(b)	**Quality of written communication**	for correct use of terms underlined in B **or** C Q ✓ Q X	1
	A – alpha particle passes straight through the empty space of the atom **or** it is a long way from the nucleus B – alpha particle <u>deflected</u> / <u>repelled</u> / <u>repulsed</u> by the (positive) <u>nucleus</u> C – alpha particle heading straight for the <u>nucleus</u> is <u>deflected</u> / <u>repelled</u> / <u>repulsed</u> backwards	describes 3 tracks correctly for **2** marks describes 2 or 1 track correctly for **1** mark do **not** accept hits the nucleus do **not** accept answers referring to refraction do **not** accept answers in terms of reflected backwards unless qualified in terms of repulsion mention of difference in charge on nucleus negates that track	max 2
total			5

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GCSE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Science: Double Award

Specification B (Co-ordinated)

3462/3F

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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4.4.4.1 Nuclear fission

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4.4.4.1 Nuclear fission

SCIENCE: DOUBLE AWARD CO-ORDINATED

INFORMATION FOR EXAMINERS

1. General

The mark scheme for each question shows:

- the marks available for each part of the question;
- the total marks available for the question;
- the typical answer or answers which are expected;
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example:
where consequential marking needs to be considered in a calculation;
or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.)

3. Marking points

3.1 Marking of Quality of Written Communication

Where *Quality of written communication* appears in the mark scheme, one mark is to be awarded for either of the following points:

- Using correct scientific terms
- Correct sequencing or linking of ideas or points

The mark scheme will specify which of the points is to be awarded in a particular question. A QoWC mark can be awarded for a scientific answer, even if it is not accurate. It cannot be awarded for a nonsensical or non-scientific answer.
On the script, the QoWC tick should be identified by a 'q' written next to it.

3.2 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

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4.4.4.1 Nuclear fission

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.3 Use of chemical symbols/formulae

If a candidate writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.4 The marking of quantitative relationships

Full credit can be given for a correct quantitative relationship expressed in:

- named units;
- physical quantities;
- standard symbols;
- a combination of physical quantities and units.

No credit can be given for any quantitative relationship expressed in terms of:

- a combination of physical quantities, units and symbols;
- a diagram, e.g. the ohm's law triangle, unless the rest of the answer shows clearly that the candidate understands the relationships involved.

3.5 Marking procedure for calculations

3.5.1 Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.
However:

- if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column;
- if the answer is correct, but an incorrect relationship is written in the working, then no marks can be awarded (see 3.5.2).

3.5.2 Where calculations are based on incorrectly recalled relationships, neither the incorrectly recalled relationship, nor the resulting calculation based on the incorrect relationship, will be credited.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

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4.4.4.1 Nuclear fission

3.7 Errors carried forward

There should be no error carried forward from a previous answer which has been based on wrong science. Any error in the answers to a structured question should be penalised once only.

Examples

(a) A candidate who calculates average speed using speed = time/distance **and** then proceeds to use this incorrect answer to calculate an acceleration based on the correct quantitative relationship should be given credit for the use of the correct acceleration relationship but none for either numerical answer.

(b) A candidate who incorrectly calculates average speed using speed = distance/time and then proceeds to use this incorrect value to calculate an acceleration based on the correct quantitative relationship, should be given credit for the use of both correct quantitative relationships **and** for the correct substitution and use of the incorrect value in the calculation of the rate of acceleration.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.8 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.9 Brackets

(…..) is used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.10 Interpretation of marginal points

There will be times when the answer is almost, but not quite, correct. Some examiners would award a mark while others would not. In any one script, an attempt should be made to balance these nearly correct answers by giving the mark on some occasions but not on others. If this is not done, the marking would end up being too lenient or too harsh.

3.11 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

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4.4.4.1 Nuclear fission

Source appendix · Full source mark scheme

June 2004 | 3462H3 | Original Q8 | Legacy

Double Award
Foundation Tier 3462/3F

3462/3F Q1

question	answers	extra information	mark
(a)	comet	correct order only	1
	elliptical		1
	Milky Way		1
	Universe		1
(b)(i)	D A C B	allow **2** marks for two letters in the correct place allow **1** mark for one letter in the correct place	3
(ii)	A		1
total			8

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4.4.4.1 Nuclear fission

3462/3F Q2

question	answers	extra information	mark
(a)	95		1
(b)	alpha	accept correct symbol	1
(c)	any **two** from: • radiation is outside the body • radiation will not reach (living) cells • radiation absorbed by the air	 accept detector is on ceiling or high up the wall accept radiation cannot pass through the body / skin accept cannot pass through the plastic casing do **not** accept because it is alpha radiation – unless qualified do **not** accept does not give off harmful substance do **not** accept cannot pass through building materials etc.	2
(d)	less (than)		1
total			5

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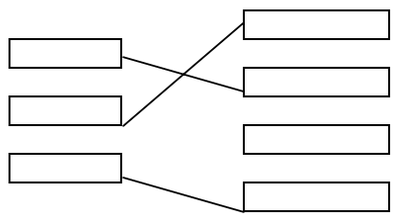
4.4.4.1 Nuclear fission

3462/3F Q3

question	answers	extra information	mark
(a)	generator	accept dynamo accept alternator	1
(b)(i)	1400	ignore units	1
(ii)	0.3 or 30%	any incorrect unit penalise **1** mark allow **1** mark for the correct use of 600 **or** 0.3% **or** 30	2
(c)	**1** mark for each correct link 	if more than 3 lines are drawn, mark only 3 lines starting with those that are incorrect	3
(d)(i)	110	no tolerance	1
(ii)	12	no tolerance	1
(iii)	wind speed may be too low to operate the generator	accept wind may not always blow accept power depends on wind speed accept does not generate if wind speed is too high accept does not generate if wind speed is above 12 (m/s) accept does not generate if wind speed is below 1.6 (m/s) accept it is unreliable do **not** accept answers referring to cost only	1
total			10

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4.4.4.1 Nuclear fission

3462/3F Q4

question	answers	extra information	mark
(a)	B E A D	allow **1** mark for each letter in the correct place, to a maximum of **3** marks	3
(b)	(a spark) may cause the (petrol vapour) to explode / ignite	accept petrol for (petrol vapour) accept catch fire for explode	1
	connect tanker to earth with a (conducting) wire / chain **or** earth the tanker	accept ground for earth	1
(c)	**Quality of written communication**	for a logical sequence	1
	any **two** from:		2
	• when current greater than fuse rating / value	accept when current too great for appliance do **not** accept 'if there is too much current' do **not** accept voltage or electricity	
	• fuse (becomes hot and) melts / burns out	accept fuse blows / breaks	
	• circuit is broken	accept circuit switched off this cannot score credit on its own	
total			8

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4.4.4.1 Nuclear fission

3462/3F Q5

question	answers	extra information	mark
(a)(i)	crust		1
(ii)	inner core is <u>solid</u> outer core is liquid	do **not** accept just rock inner core is denser / hotter than outer core gets **2** marks accept one is solid and one is liquid for **1** mark accept they are different densities for **1** mark wrong way round = **0** marks	1 1
(b)	seismograph		1
(c)	difficult to measure (slow) movement (1) of plates (1) dependent mark **or** difficult to measure friction / forces (1) between plates (1) dependent mark		1 1
(d)	geothermal		1
(e)(i)	5000		1
(ii)	2500		1
total			9

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4.4.4.1 Nuclear fission

3462/3F Q6

question	answers	extra information	mark
(a)	60		1
(b)	$5\frac{1}{2}$ hours	must include unit	1
(c)	30		1
(d)	30 minutes or $\frac{1}{2}$ hour	must include unit	1
(e)	D **and** E least steep part of the graph	accept finish for E accept correct numbers from axes with units accept covers smallest distance in a set time accept only moves 5 km in $1\frac{1}{2}$ hours (accept anything between 5 and 6) ignore horse is tired	1 1
total			6

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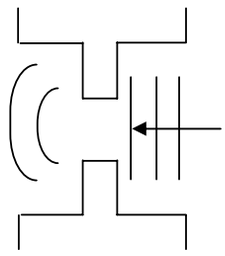
4.4.4.1 Nuclear fission

3462/3F Q7

question	answers	extra information	mark
(a)(i)	any **one** from: • (doctors) to see inside a patients body **or** endoscope • telephone cables • optical fibre / fibre optic lamps **or** (artificial) Christmas trees • data transfer **or** internet connection	 accept keyhole surgery do **not** accept flex **or** wires for cable accept decorative / ornamental lighting accept any feasible practical suggestion for taking light to a difficult to access place do **not** accept lighting unqualified do **not** accept lamp unqualified do **not** accept communications unless clarified	1
(ii)	(incident) ray angle greater than critical angle total internal reflection occurs	either order accept (incident) ray greater than 42° accept TIR do **not** accept just description of TIR	1 1
(b)(i)	waves shown diffracting in the correct direction 	ignore wavelength	1
(ii)	diffraction	accept diffract / diffracted	1
total			5

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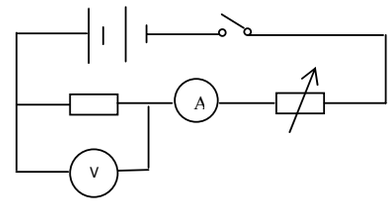
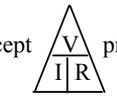
4.4.4.1 Nuclear fission

3462/3F Q8

question	answers	extra information	mark
(a)	all symbols correct	 accept push switch symbol switch may be open or closed any lines through symbols = **0** marks	1
	correct circuit drawn voltmeter must be across resistor only	polarity of cells not relevant provided they are joined correctly two cells are required in the diagram ignore the order of the components allow small gaps in circuit omission of any component = **0** marks	1
(b)(i)	potential difference = current × resistance	accept voltage or p.d. for potential difference accept $V = I \times R$ accept  provided subsequent use correct do **not** accept C for current	1
(ii)	2	 allow **1** mark for correct substitution wrong working loses both marks	2
(iii)	straight line drawn <u>through the origin</u> straight line passes through $I = 0.4, V =$ their (b)(ii) / 2 **and** 0.0	judge by eye this mark may be awarded if all points shown including these points are correct even if no line is drawn N.B. a curve scores **0** marks	1 1 dep
(c)	temperature <u>increases</u>	accept filament lamp / it gets <u>hotter</u> allow heat for temperature	1
total			8

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4.4.4.1 Nuclear fission

Source appendix · Full source mark scheme

3462/3F Q9

question	answers	extra information	mark
(a)(i)	gamma rays	accept gamma accept correct symbol	1
(ii)	infra red	accept IR	1
(b)	ultraviolet <u>absorbed</u> by ink (energy) given out as light	 accept glows / luminous accept for **both** marks the ink is fluorescent do **not** accept answers in terms of uv being reflected	1 1
(c)	any **two** from: • UV can damage / kill / ionise / alter (normal) cells • change DNA structure **or** mutate • (normal) cells may become cancerous	 do **not** accept attacks cells **or** burns skin accept may cause (skin) cancer accept abnormal cell multiplication	2
(d)(i)	microwaves **and** infra red	both answers needed in either order do **not** accept heat for IR	1
(ii)	0.9	allow **1** mark for the <u>correct</u> use of 1.8 (kW) $(1.8 \times \frac{1}{2}$ or $1.8 \times 30)$ i.e. adding the correct 2 power values	2
total			9

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4.4.4.1 Nuclear fission

3462/3F Q10

question	answers	extra information	mark
(a)(i)	accelerating	accept getting faster accept speed / velocity increasing	1
(ii)	acceleration increases	accept velocity / speed increases more rapidly do **not** accept velocity / speed increases	1
(b)(i)	$\text{acceleration} = \frac{\text{change in velocity}}{\text{time (taken)}}$	accept $a = \frac{v - u}{t}$ **or** $a = \frac{v_1 - v_2}{t}$ do **not** accept velocity for change in velocity do **not** accept change in speed do **not** accept $a = \frac{v}{t}$	1
(ii)	15	allow **1** mark for an answer of 900 **or** for correct use of 540 seconds	2
(iii)	velocity includes direction	accept velocity is a vector (quantity) accept converse answer	1
(c)	force of gravity (between shuttle and Earth) plus correct orbital speed (makes shuttle move in a curve)	accept gravitational pull if used correctly accept forward motion **or** constant speed for orbital speed accept it is travelling fast enough accept for **2** marks the force of gravity provides the centripetal force	1 1
(d)	black is a good emitter of radiation **or** to limit the temperature rise inside the shuttle	accept heat for radiation accept the tiles are good insulation do **not** accept black absorbs heat on its own do **not** accept tiles are heat proof	1
total			9

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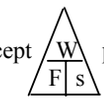
4.4.4.1 Nuclear fission

3462/3F Q11

question	answers	extra information	mark
(a)(i)	work (done) = force (applied) × distance (moved)	accept W = F × s or W = F × d accept  provided subsequent method is correct	1
(ii)	240 000 joules	allow **1** mark for correct substitution **or** correct use of 1200 (N) accept J do **not** accept j / Nm	2 1
(b)	800 (watts)	accept 0.8 kW accept their (a)(ii) ÷ 300 correctly evaluated for **2** marks allow **1** mark for correct substitution (a)(ii) ÷ 5 correctly evaluated for **1** mark	2
(c)(i)	any **one** from: • needs to raise the chair / lift • lifting more than one chair • energy transfer to the surroundings correctly qualified	 allow lifting more than 2 people implication of a heavier weight accept loss for transfer do **not** accept motor inefficient do **not** accept motor gets hot do **not** accept friction unless the location is specified as external to the motor	1
(ii)	electrical potential	accept electric **both** answers required for the mark	1
total			8

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4.4.4.1 Nuclear fission

3462/3F Q12

question	answers	extra information	mark
(a)	**Y** and **Z**		1
	they have the same number of protons **or** same atomic number	accept they have the same number of electrons **or** same number of protons **and** electrons allow only different in number of neutrons N.B. independent marks	1
(b)	**Quality of written communication**	for correct use of terms underlined in B **or** C Q ✓ Q X	1
	A – alpha particle passes straight through the empty space of the atom **or** it is a long way from the nucleus B – alpha particle deflected / repelled / repulsed by the (positive) nucleus C – alpha particle heading straight for the nucleus is deflected / repelled / repulsed backwards	describes 3 tracks correctly for **2** marks describes 2 or 1 track correctly for **1** mark do **not** accept hits the nucleus do **not** accept answers referring to refraction do **not** accept answers in terms of reflected backwards unless qualified in terms of repulsion mention of difference in charge on nucleus negates that track	max 2
total			5

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4.4.4.1 Nuclear fission

Answer 14 · Examiner comments

November 2020 | 8463/1H | Original Q5

Question 5 (Standard/High demand)

05.1 40% of student scored a mark on this question. Electronics, microwaves, phones and food and drink were common incorrect responses. Man-made doesn't mean 'made by man' in this context it refers to the radiation source being artificial rather than naturally occurring. Incorrect answers commonly seen included things which are not man-made, eg sunlight, cosmic rays, other types of radiation which do not contribute to background radiation like microwaves or infrared.

05.2 74% of students could name a nuclear fuel. The most popular answer being 'uranium'. Commonly seen incorrect answers included coal, oil, gas and petrol.

05.3 Only 6% of students scored all 4 marks. To score the first marking point, students needed to indicate that the neutron becomes part of the U-235 nucleus, it was insufficient to only say that the neutron collides with the nucleus. Very few students scored the 4th marking point. Many students hadn't revised the process, evidenced by their meandering discussion of different radiation types and gold sheets. Whilst many students had some idea of the nuclear fission process, they often failed to gain marks because their answers lacked detail or were imprecise, eg neutrons being absorbed by 'atoms' rather than 'nuclei', a nucleus 'splitting' without the detail of two daughter nuclei being produced. A number of students went on to describe the chain reaction and / or the process of electricity generation which was unnecessary.

05.4 Only 8% of students scored both marks, with 29% of students scoring 1 mark. Elements fuse or atoms fuse was insufficient. Nuclei fuse was insufficient unless they said to form a larger / heavier nucleus. Very few knew that some of the mass of the nuclei was converted into energy. Some students fell back on their knowledge of chemical reactions and mentioned breaking bonds and exothermic reactions.

05.5 Only 8% of students scored 2 marks, 39% of students scored 1 mark. Very few students linked the short half-life to how the activity of the waste would change with time. Most students who scored the first marking point did so for saying the radioactive waste would decay quicker. Students tended to score the second marking point rather than the first, although vague statements like less harm/damage to the environment were insufficient.

4.4.4.1 Nuclear fission

Answer 16 · Examiner comments June 2025 | 8463/1H | Original Q5

05.1

Just over 80 % of the students scored 2 marks for correctly describing what is meant by an isotope of an element. The number of electrons was ignored as this does not define an isotope.

05.2

Students needed to say light / lighter / small nuclei to demonstrate they understood that it is only lighter nuclei which fuse. The word fuse could have been substituted for other words like 'join', or 'combine' but 'collide' was insufficient. Some students demonstrated an excellent understanding of the fusion process and fusion in stars was accurately described. Fusion on earth where an extra neutron is released was ignored, as the process as stated in the specification was being tested. Just fewer than 20 % of the students scored 3 marks, while nearly 30 % of the students scored 2 marks and approximately 15 % of the students scored 1 mark.

05.3

Most students who scored a mark did so for stating that the reactor walls should not melt. Few students scored the first marking point. Most students were vague and used phrases like the walls need to 'withstand the high temperatures' which did not score a mark. Many students confused specific heat capacity with thermal conductivity and thermal insulation. Containing the fusion energy or products was another common insufficient response. Only

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Answer 16 · Examiner comments June 2025 | 8463/1H | Original Q5

about 4 % of the students scored 2 marks, while approximately 40 % of the students scored 1 mark.

05.4

Just over 30 % of the students scored the mark for the consequence of an uncontrolled chain reaction. 'Explosion' unqualified was insufficient to score the mark.

4.4.4.1 Nuclear fission

AQA
Questions matter

GCSE

Physics

8463/1H Paper 1 Higher Tier

Report on the Examination

8463
June 2024

Version: 1.0

4.4.4.1 Nuclear fission

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4.4.4.1 Nuclear fission

REPORT ON THE EXAMINATION – GCSE PHYSICS – 8463/1H– JUNE 2024

General

Grade 4-5 calculation questions ask for students to recall an equation first before using it in a subsequent calculation, however in the 2024 series, students were given a Physics Equations Sheet which had all the equations printed on it. Subsequently, the performance on straightforward calculations has improved compared with years when equations have needed to be recalled from memory.

The grade 8-9 multistep calculations, question **05.5** and **06.2**, were well attempted. Question **05.5** had 18% of students scoring 5 marks, while question **06.2** had 14% of students scoring 6 marks.

Question **03.1** was well attempted and students who had carried out the resistance of a wire required practical would have had a material advantage over those who hadn't. For this question, 44% of students scored 5 or 6 marks and 37% of students scored 3 or 4 marks.

Handwriting continues to be a problem for a number of students, making it very difficult for examiners to read what has been written. An increasing number of students are using computers to word process their answers for extended response questions, which is helpful for examiners in awarding credit for student responses. However, students must use the question number as printed in the question paper eg 4.3 rather than 4(c) to ensure that their work is marked with the corresponding question part.

Levels of demand

Questions are set at three levels of demand for this paper:

- **Standard demand** questions are designed to broadly target grades 4–5.
- **Standard/high demand** questions are designed to broadly target grades 6–7.
- **High demand** questions are designed to broadly target grades 8–9.

A student's final grade, however, is based on their attainment across the qualification as a whole, not just on questions that may have been targeted at the level at which they are working.

Question 1 (Standard Demand)

01.1 98% of students scored this mark, identifying the energy store which increases when water is heated.

01.2 93% of students scored this mark. Some incorrect answers seen were 'method A' or 'method B' students thinking they were linking a method to the energy transfer. Another common answer was 'hydroelectric energy' which didn't score. The word 'potential' was needed for an answer of 'gravitational potential.' As the question was worded it seemed reasonable to credit 'kinetic' since the water moving uphill would have kinetic energy before it reached its destination and stored only gravitational potential energy.

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4.4.4.1 Nuclear fission

01.3 55% of students scored 4 marks. Some students failed to realise that the calculations needed were to show the amount of stored energy wasted or the amount of stored energy usefully transferred. Simple subtractions were insufficient to score the calculation marks. To score 4 marks, two comparisons were needed in addition to a comparative calculation. Although the comparative calculation performed by a minority of students involved dividing 33 600 kJ by 490 kJ and getting an answer of 68.6, which is the number of times more energy stored by method A compared to B. This single calculation was enough to score 4 marks with the two simple comparisons. The installation comparison only scored if value was added to the information eg Method A is easier to install or is likely to cost less money.

01.4 To score marks for this question, students needed to say what activity should be stopped (or reduced) and what should be done instead for both transport and electricity generation. At its simplest this could be use electric cars instead of petrol cars and use renewable methods instead of fossil fuels to generate electricity. As well as the examples on the mark scheme other valid methods were also creditworthy: car sharing, for example, or limiting the distance that goods could be shipped across country. 39% of students scored 4 marks, while 35% of students scored 3 marks.

Question 2 (Standard Demand)

02.1 A sentence completion question about nuclear fission which discriminated well between students. 72 % of students scored 3 marks, 21% scored 2 marks and 5% scored 1 mark.

02.2 99.5% of students scored the mark for writing down the correct equation. However, in this exam series all equations were provided for the students on the Physics Equations Sheet.

02.3 A standard demand calculation of energy question. 48% of students scored 3 marks, while 41% of students scored 2 marks. Not converting or incorrectly converting the unit will have allowed many students to only score 2 marks.

02.4 44% of students scored a mark. ‘Wear protective clothing’ or ‘hazmat suits’ were common incorrect answers. Any idea of ‘burying it’ was credited, so ‘bury it in a field’ was ok, as was ‘bury it in landfill,’ which from a student’s perspective is equivalent to burying it underground. ‘Keeping it away from people’ was insufficient.

02.5 96% of students scored 2 marks. The answer of 29.2 days was worth 1 mark as this could only have been calculated by doing the correct calculation and then subtracting the result from 365.

Question 3 (Standard/High Demand)

03.1 Students who had completed the investigation found this question straightforward, especially as the circuit was shown in a photo. It was not necessary for the circuit connections to be described. The mean mark for the question was 4 marks. 44% of students scored 5 or 6 marks, while 37% of students scored 3 or 4 marks.

03.2 83% of students identified the graph showing the relationship between length of wire and resistance.

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03.3 28% of students scored 2 marks, while 50% scored 1 mark. The converse of 'low p.d.' was the bare minimum to score the first mark, so 'not a high p.d.' was taken to mean the p.d. was low. Similarly, 'not enough to give you a shock' and 'not enough to electrocute you' were creditworthy for the second mark.

Question 4 (Standard/High Demand)

04.1 Students answers were generally very confused with this question and statements about transfer of positive electrons or protons or even neutrons were commonly seen. Students struggled to understand that when you are in contact with a charged object you have the same charge as that object. It was common to see statements about the dome being negative so the student (and her hair) are positively charged. If a student said that the student was positively charged they could not score mark points 1 and 2, but they could still score mark point 3 if they said that like / same charges repel. 10% of students scored 3 marks, while 15% scored 2 marks and 32% scored 1 mark.

04.2 Only 8% of students scored a mark on this question. An answer of 'the area / space / region where an electron experiences a force' was creditworthy as were other examples of charged particles or ions. 'The area where other charged particles experience repulsion or attraction' was also creditworthy. Neither of these examples were seen often, however.

04.3 92% scored a mark for this question. A surprisingly large number of students made statements like 'as you get closer to the dome, the field strength increases' answering the question in the opposite way to the way it was set out. They scored a mark but would have saved a lot of time by writing 'it decreases.'

04.4 Some students did not convert, or incorrectly converted, the unit of charge and scored 3 marks.. Some students incorrectly converted the unit for charge and also spuriously converted the energy by multiplying or dividing by a power of ten. These students made two mistakes, so scored a maximum of 2 marks on this question. 36% of students scored all 4 marks, while 56% of students scored 3 marks for this calculation of potential difference.

04.5 80% of students identified the factor that would increase the distance a spark can jump between two objects.

Question 5 (Standard/High Demand)

05.1 72% of students scored 2 marks, while 15% of students scored 1 mark. A number of students thought mains p.d. was 240 V. It was officially changed to 230 V in 1987 and this is the value given in the specification. However, it was more common for students to get the p.d. correct and the frequency incorrect.

05.2 A grade 6-7 calculation of resistance, which discriminated well between students. The conversion of milliwatts to watts proved a problem for the vast majority of students. 53% scored all 4 marks, while 36% scored 3 marks.

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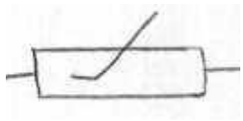
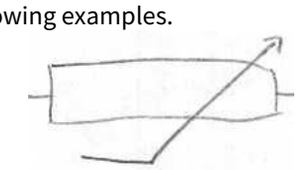
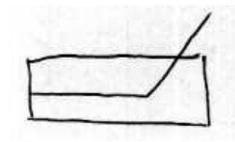
05.3 64% of students scored a mark for suggesting why dirty coins are not recognised by the machine. Answers which were insufficient, but ignored, included 'Can't measure resistance' and 'Dirt is an insulator'..

05.4 63% of students scored a mark for drawing the thermistor symbol. Answers that were not acceptable included the following examples.

05.5 This grade 8-9 calculation, worth 5 marks, question discriminated well between students of different abilities. If a student did not calculate the total resistance and then use that value to calculate the current in the circuit, then they didn't score the first 3 marks. If a student calculated the current in the circuit using just the 400 Ω resistor, then they could use that value to score the 4th and 5th marks for the calculation of the p.d. across the thermistor, using $V = IR$.
Answers with a p.d. greater 12 V usually scored zero marks, due to fundamental Physics errors.
18% of students scored 5 marks, while 31% of students scored 2 marks. 46% of students scored 0 marks. In this exam series all equations were provided for the students on the Physics Equations Sheet.

Question 6 (High Demand)

06.1 90% of students scored this mark, for identifying that the elastic potential energy store increases as the bungee cords are stretched.

06.2 A challenging grade 8-9 calculation question. A common incorrect answer was '10' which scored 5 marks because the only mistake the student made was not doubling the elastic potential energy calculated for one bungee cord. Due to the various ways students approached the question it discriminated well between different abilities. 14% of students scored 6 marks, while 34% scored 5 marks and 28% scored 4 marks. As long as a student had used the elastic potential energy equation calculating a value of E_e using a value of k and e^2 they could score the marks for using the E_p equation.

06.3 12% of students scored 2 marks, while 46% of students scored 1 mark, in this question for identifying the ways in which energy was dissipated.

Question 7 (Standard/High Demand)

07.1 52% of students scored this mark. The question states that the student's eye is not in line with the level of the water. The position of the eye is likely to remain in the same (incorrect) position as the water level changes when the ring is inserted. This will cause a random error as both volume measurements will be incorrect, but not by the same amount.

07.2 63% of students scored this mark. Additional mass or absorbing extra water were ignored. The answer needed to make a comparison, rather than just state that 'volume of string affects the measurement of volume.'

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4.4.4.1 Nuclear fission

07.3 33% of students scored the mark for this question about resolution. Comments on low / high resolution were insufficient to score. Statements needed to refer to the resolution value itself or the number of decimal places the measurement could be read to. As measuring cylinders often have large gaps between markings, a statement that the resolution was 0.1 cm^3 was allowed.

07.4 71% of students scored a mark for this question about zero error. Common incorrect answers said, 'take repeat readings and calculate a mean.'

07.5 A grade 6-7 calculation question, but the unit conversion made this question more difficult than other similar calculations in the exam, with only 33% of students scoring all 4 marks. 57% of students scored 3 marks.

Question 8 (High Demand)

08.1 Questions about the microscopic causes of pressure are difficult for GCSE students and this question was no exception. Many students repeated information given in the question which did not score any marks. A minority of students scored the first mark point, many students simply stating that the volume decreased which was insufficient. Students made a good attempt at explaining that there were more collisions between the particles and the container walls, but failed to score because they didn't refer to a specified time period e.g. per second, or rate or more frequent, etc. Some students stated that the kinetic energy of the particles had increased, which stopped them from scoring the second mark point. Very few students scored the third mark point which was the most demanding of the three. 9% of students scored 2 or 3 marks, while 43% of students scored 1 mark.

08.2 94% of students scored this mark, linking temperature increase to mean kinetic energy of particles.

08.3 A grade 6-7 calculation question which discriminated well between students. Many students failed to convert the specific heat capacity so scored 3 marks instead of 4. Some students tried to convert the energy into kJ but very few did this successfully, usually ending with a 'power of 10' error. 22% of students scored 3 marks while 62% of students scored 4 marks.

Question 9 (High Demand)

09.1 Students needed to refer to the graph, and factual recall about alpha radiation, to score the 1st and 3rd mark points.,. The 2nd mark point was much more unlikely to score, as students often stated the graph went to zero, rather than being just above zero. A number of students confused the graph with a half-life graph, believing the *x*-axis showed time, not distance. 8% of students scored 3 marks, while 45% scored 2 marks and 35% scored 1 mark.

09.2 A lot of students thought it was enough to say 'an absorbing material' without specifying what the absorbing material should be made from. Any suitable absorbing material was creditworthy, a block of wood for example. However, reference to any metal foil was not creditworthy unless students referred to a certain thickness eg 5 mm thick aluminium foil. A 'foil' was taken to be the same thickness as kitchen foil, whereas a 'metal sheet' was taken to be thick enough to absorb

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4.4.4.1 Nuclear fission

beta radiation, provided students did not contradict their earlier statements. Paper and cardboard were not creditworthy as suitable absorbing materials. 51% of students scored 2 marks, while 7% of students scored 1 mark.

09.3 65% of students scored this mark by suggesting a suitable safety precaution. Hazmat suits and PPE were insufficient to score.

09.4 64% of students scored this mark by suggesting a suitable precaution to avoid contamination. Hazmat suits and PPE were insufficient to score.

09.5 Students at GCSE find the idea of rate of change to be a difficult one, hence linking the change in the number of atoms to activity was a difficult question in this exam series. 7% of students scored 4 marks, while 12% of students scored 3 marks. If students failed to draw a tangent, they were very unlikely to score any marks except the unit mark. A common incorrect choice of unit for activity for many students was sieverts, Sv. Examiners were looking for becquerel or Bq. Decays per second or decays/second were insufficient to score.

Question 10 (Standard/High Demand)

10.1 72% of students correctly identified the colour of the live wire insulation.

10.2 66% of students scored the mark on this question. Students who made the box for the answer into a fuse symbol did not score the mar nor did a fuse symbol added to any side of the box .

.

10.3 A grade 6-7 calculation of current. 57% of students scored all 4 marks. 36% of students scored 3 marks, usually for incorrectly converting, or not converting, the unit.

10.4 A grade 6-7 calculation of mass. 61% of students scored 4 marks. 31% of students scored 3 marks for either incorrectly converting, or not converting, the unit.

10.5 40% of students scored 2 marks on this question recognising that the time would be longer because more energy in total would need to be transferred. An answer of ‘less energy is melting the wire’ was just enough to score the second mark. 15% of students scored zero on this question.

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4.4.4.1 Nuclear fission

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

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